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AUTHOR Bazillion, Richard J.
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ABSTRACT

Information technology is having a profound effect on higher education in North America, and Brandon University in Manitoba (Canada) is in a position to join this movement in its early stages. The case for integrating information technology into the curriculum is argued, and the potential role of the new library complex in the teaching function is outlined. The recent expansion of the campus information network, MONET, has enhanced opportunities for faculty members, but this technology has yet to be extended to students. The new library is planned to allow the incorporation of information technology into the curriculum, should the university and the community elect to move students into the information technology age. Practical suggestions are offered to accomplish this. A first step is to begin developing courses that apply information technology to the specific research assignments required of students. A second, longer-range task is to create new courses on the history, sociology, and psychology of the information society, so that students gain an intellectual context in which to place contemporary events. It will also be essential to ensure that the technological infrastructure of the campus does not become progressively obsolete because of financial constraints. An appendix provides an annotated bibliography that lists 45 sources of additional information. (Contains 42 references.) (SLD)

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# INFORMATION TECHNOLOGY

## A Model for Brandon University

RICHARD J. BAZILLION
Director of Library Services

Office of the
Vice-President ( Academic & Research)

A Publication of Brandon University Library

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# INFORMATION TECHNOLOGY:

# A MODEL FOR BRANDON UNIVERSITY

Richard J. Bazillion

Director of Library Services

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1993

# FOREWORD

My reasons for distributing this paper within the university community are (1) to argue the case for integrating information technology into the curriculum and (2) to describe the potential role of our new library complex in the teaching function of the university. The underlying assumption is that information technology is having a profound effect on higher education in North America, and that Brandon University has an opportunity to join this movement in its early stages. If we are able to seize the moment, certain advantages will accrue. Not only will we be able to use our new library facility to its fullest, but we also will enhance our reputation as innovators in the application of technology to education.

Several colleagues, all of whom share an interest in information technology, contributed in ways they may not recognize to the evolution of this document. Daryl Kines laid out the conduit system that will connect library study spaces to the campus information network; he is also helping to design study furniture that can accommodate computer use. Dr. Gerald Dueck configured the campus information network to provide access to a variety of databases and utilities. Bruce McFarlane suggested ways in which the computerized library can support our distance-education efforts. Connie Braun, who has been involved in the building project from the beginning, located most of the sources on which this paper is based and contributed to the formation of views expressed in it. As Head of Information Services, she will be responsible for implementing any practical ideas found herein. Gallagher McGuinness offered shrewd criticism and suggestions on course design in a computerized environment. Having seen some merit in these proposals, Dr. Susan Hunter-Harvey approved their circulation. Our hope is that a stimulating and productive discussion will ensue.

R.J. Bazillion

March 31, 1993

# Information Technology:
# A Model for Brandon University

> Much of the adoption of a new technology depends on the symbolism it evokes. And whatever else it may be or become, the computer and the terminal workstation are symbols of a modern university.[1]

## Introduction

Completion of the new library building, which incorporates information technology into its fabric by means of an in-floor conduit grid, offers a good occasion to ponder recent developments in computer communications. Electronic information retrieval is a familiar activity on campuses whose libraries have online catalogs. Most faculty members, at one time or another, have consulted an online information source in the course of their research. With the expansion of the campus information network ("MONET"[2]), faculty have gained access to locally-mounted databases such as *Current Contents* and, at a future date, Statistics Canada's *Census '91* on networked CD-ROM. These information sources have been created by the library (e.g. BuCAT[3] and several of its sub-menu items), or else have been brokered by the library. Although they represent just the tip of the information-technology iceberg, they are mainly what students see.

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[1]James G. March, "Old colleges, new technology," in: Sara Kiesler and Lee Sproull (eds.) *Computing and Change On Campus*, (Cambridge, 1987), p. 16.

[2]MONET Software © Gerald Dueck, 1992.

[3]BuCAT © TKM Software Ltd., 1992.

Strangely enough our students are often excluded from the larger world of information technology. They do learn, one way or another, to become proficient at using BuCAT. Because students normally lack password access to MONET, they are unable to use the Internet or even campus e-mail. They may remain completely unaware of the universe of electronic information sources, including online journals and bibliographic databases, that is accessible to faculty. Users usually have to pay for many online services, and this in itself tends to limit student participation. As information technology evolves the user-pays principle will become firmly established. The Canada [sic] Institute for Scientific and Technical Information (CISTI), for example, is currently marketing itself to the federal government as a potentially profitable enterprise.[4] CISTI's university clientele, which accounts for about 20 percent of its business, naturally will be expected to pay for information once provided without charge. Developments like these admittedly impede efforts to integrate information technology into the university curriculum. But they must not be allowed to prevent students from learning the research skills required to function in what is commonly known as the "information society."

In order to give Brandon University an edge, should it decide to incorporate information technology in its curriculum, the new library has been designed to facilitate electronic scholarship. Each study space is provided with a connection to MONET. All phases of a research project, from bibliographic work to the composition of papers, can be carried out from a "wired" carrel. The new user-instruction room will have the equipment needed to teach electronic research techniques. Library and Media Center staff are prepared to work with faculty in designing courses and assignments that focus on the application of information technology. Despite financial and pedagogical obstacles, we must find ways to apply new technologies to classroom teaching.

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[4]National Research Council Canada. Canada Institute for Scientific and Technical Information. *CISTI: A Plan for the Future*. (Ottawa, 1992), 26p.

The following discussion is intended to argue for the adoption of an information-technology strategy. As Manitoba universities, along with other provincial systems, come under public scrutiny in the months ahead, now is the proper time to chart a unique course for Brandon University, one that will distinguish us from other institutions similar to our own. We could decide, for example, that our students should be educated in the use of information technology, and in the origins and development of the new society that is emerging in response to rapid technological change. If we can defend this strategy, we will stand a better chance of claiming a reasonable share of diminishing public support. On the other hand, if we remain attached to the status quo, both intellectually and institutionally, then our prospects are not especially good.

With the new library as an example of what is possible, we have an opportunity to convince the government that we can approach innovation in a practical way. We can demonstrate an ability to produce graduates who are both educated and skilled in the techniques of electronic research and communications that the marketplace demands. Obviously this is not an argument that the university should involve itself in job training. It just so happens that the research abilities we are able to impart to our students are those valued by modern industry. This fortuitous connection offers us the best chance we are ever going to get to define a unique role for ourselves. Even a penurious government may be persuaded to help fund our efforts.

## Definitions

***Information technology*** embraces the computerized systems and software used in the research process. Its main purpose is to enable fast and comprehensive access to electronic information sources consisting of literature citations of the sort normally found in traditional indexes or abstracts, or the full text of a particular document. An online library catalog, such as BuCAT, is an "information base" composed of several "databases": author, subject and title files; bibliographic records; circulation information; holdings information.[5] There are many kinds of information bases, including:

---online electronic utilities such as the DIALOG system, BRS, CompuServe and the like

---CD-ROM, which is currently the favored means of publishing large data collections, but which has inherent limitations related to (a) the variety of search protocols used by such systems and (b) the difficulty of providing access to multiple users

---locally-mounted downloadable magnetic tape, which enables the library to make certain commercial databases, such as, the H.W. Wilson indexes, available through BuCAT

---online catalogs of most of the world's major research libraries accessible via the Internet, which is a world-wide "electronic highway"

---assorted document-delivery services, such as the new "CARL UnCover", "Faxon Finder" or *Current Contents*, which

[5]Clifford A. Lynch and Cecilia M Preston, "Internet access to information resources," in: Martha E. Williams (ed.), *Annual Review of Information Science and Technology*, 25 (1990), p. 288.

allow subscribers to identify and order specific publications

---government-produced information bases, such as the census series published by Statistics Canada

---other electronic information sources available on campus information networks

Each information base has an associated search protocol, which must be learned by those who wish to examine its contents. Familiarity with one or more systems does make the learning process somewhat easier; but the great variety of protocols remains an obstacle to access. Standards intended to govern how one machine communicates with another are under development and will, in due course, solve the problem.

Information technology also encompasses a vast array of software that analyzes data and produces text. Two common examples are *WordPerfect* and *Lotus 1-2-3*. Programs also exist that enable researchers to handle the scholarly apparatus used to document sources and to print camera-ready copy of a completed paper or book (e.g. *Pro-Cite*, *Nota Bene*). Virtually every academic discipline now has specialized software, e.g. SPSS, to assist the research process.

***Computer literacy*** is related to the idea of information technology, but is not synonymous with it. Dartmouth College, in the mid-1970s, defined "computer literacy" as the ability to write a computer program.[6] Carnegie-Mellon University's Task Force for the Future of Computing on campus offered a broader definition in its 1982 report:

> Computer literacy is not equivalent to learning to program, but is different in at least the following ways: First, using a computer often means not programming, but using available tools--editors,

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[6]John M. Nevison, *Computing as a Matter Of Course: The Instructional Use of Computers at Dartmouth College*, (Hanover, NH: Dartmouth College, Kiewit Computation Center, July 1976), ERIC, ED 160061, p. 1.

> electronic mail, statistical packages, simulators, computer-aided design systems, data base systems, and so on.... Second, using a computer effectively involves more than just local skills for using particular languages or tools. It requires understanding the fundamental nature of the computer, what kinds of things it can and cannot do. Third, if the role of computation is to increase..., computer literacy must include competence in the local computational facilities. This part of computer literacy is in fact an important part of good access.[7]

Carnegie-Mellon's conception of computer literacy recognizes the evolutionary direction of campus automation, and is as valid today as it was a decade ago. The university's vice provost for computers and planning, Douglas Van Houweling, said at the time: "We don't believe that all students should know how to program.... It's more important that people are able to use the computing tools that are directly relevant to their fields."[8] This comment parallels a definition of computer literacy proposed in 1980 by the Duke University Personal Computing Project: "an awareness of computing capabilities within a discipline or profession, and an ability to recognize and articulate problems that can be solved with the aid of computing technology. The definition does not necessarily imply an ability to program or operate computers."[9]

Now that a wide variety of information-technology software is easily obtainable, those who wish to be computer literate must know how to "operate"

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[7] Marc S. Tucker, "The 'Star Wars' universities: Carnegie-Mellon, Brown, and M.I.T.," in: Tucker (ed.), *Computers on Campus: Working Papers: Current Issues in Higher Education*, (Washington, DC: American Association for Higher Education, 1983), ERIC, ED 240947, p. 6. Ten years later CMU remains committed to incorporating information technology into the teaching and learning process.

[8] Peggy Brown (ed.), *Computer Literacy...Would Plato Understand?*, (Washington, DC: Association of American Colleges, May 1983), ERIC, ED 231263, p. 5.

[9] Quoted in Carolyn Marvin and Mark Winther, "Computer-ease: a twentieth-century literacy emergent," *Journal of Communication*, 33 (Winter, 1983): 105.

a machine. For most of them the need to write special-application programs will never arise. Either the particular situation has been addressed already, or else expert assistance is available in the university's computer services department. In any event, programming knowledge no longer is the *sine qua non* of computer literacy. Facility with word-processing and computational software, along with the ability to search electronic information bases, is today's imperative.

Another aspect of computer literacy is recognition of the computer's ability to influence the process by which information is turned into new knowledge. Machines are efficient manipulators of data; but it is human intelligence that creates knowledge out of this new material. If "knowledge is structured through the characteristics of the technology," then "computer technology reinforces a particular pattern of thinking."[10] That pattern may result in false literalness if too much credence is placed in simple quantification, i.e. unquestioning acceptance of conclusions based on computerized data analysis. Statistical relationships identified by the computer have to be critically evaluated in the same way as any other correlation between or among variables, however derived. As a philologist with long experience in computer use puts it:

> The computer reveals its limit exactly where philology is at its strongest: the interpretation of the whole from the whole. This consists of the intuitive insight into the formula, form, value and meaning of the whole.... In some real sense here, it is the synthesis which precedes the analysis.[11]

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[10]C.A. Bowers, "Teaching a nineteenth-century mode of thinking through a twentieth-century machine," *Educational Theory*, 38 (Winter, 1988): 43.

[11]Roberto Busa SJ, "Informatics and new philology," *Computers and the Humanities*, 24 (1990): 340.

Between mind and machine, the relationship is always a symbiotic one. On this fact rests the association among information technology, computer literacy and education.

## Information Technology and Education

Information technology, in its electronic form, has been around for less than two decades. Desktop computers now possess the power of earlier mainframes, and emphasis has shifted to portable computing power. Today it is possible to use a small but fully-featured notebook computer to gain access to global information networks through a telephone connection. Data sets and literature citations may be downloaded, analyzed, arranged and re-transmitted. Electronic file transfer allows researchers to exchange information, data and work-in-progress. To say that information technology has revolutionized the process of scholarly communication is almost a truism. Electronic journals, edited online and available over the Internet, are becoming increasingly common.[12] Traditional paper-copy indexes, abstracts and bibliographies are well on the way toward extinction. Scholarly research without the aid of information technology is becoming ever more difficult.

The technology itself is evolving so quickly that remaining current is a challenging task. At the same time, the diffusion of new technologies into society at large is accelerating. Professionals in such fields as medicine, engineering and the law have discovered that access to electronic information sources is indispensable. They are finding, moreover, that it is more efficient to

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[12]William Y. Arms, "Scholarly publishing on the national networks," *Scholarly Publishing* 23 (April, 1992): 158-169. Michael Strangelove and Diane Kovacs, *Directory of Electronic Journals, Newsletters and Academic Discussions Lists*. 2nd ed. (Washington, 1992).

perform their own database searches rather than to call on an intermediary, such as a librarian, to do the work for them. The demand is growing for university graduates who can use the technology and who understand the general lines of its evolution. How are the universities responding to this situation, if indeed the majority are listening at all?

An increasing number of universities in the United States, among them Dartmouth College, Brown University, Drexel University, M.I.T, Carnegie-Mellon University and Rensselaer Polytechnic Institute, are integrating information technology into their classroom teaching. Students at Carnegie-Mellon have been required to own a computer since 1986. They use the machine throughout their academic careers for the whole range of tasks involved in completing course assignments; it is paid for over the four years required to earn a degree. Information-retrieval techniques are taught within the context of specific academic disciplines. When students graduate, they possess the research skills required to succeed in occupations that demand the ability to turn existing information into new knowledge.

The model described briefly above is not widely emulated outside technical or scientific fields and institutions. Undergraduate liberal arts colleges appear to be making less use of it, despite the fact that their graduates also must function in a marketplace permeated by information technology. There is no inherent reason why this should be the case, because the technology--in the form of citation databases and compositional software--applies to both the humanities and the social sciences. There is no justification for ignoring information technology, which is quite capable of blending with the traditional values of reasoned discourse, felicitous expression and scholarly rectitude. Whether a poem is composed on a word processor or with a quill pen, or produced on a laser printer rather than typeset, affects its intrinsic value not at all. Linguistic analysis, textual criticism, the comparison of source documents and statistical abstraction can all be assisted by the computer. Every academic discipline is affected, to a greater or lesser extent, by information technology.

Scientific and technical departments adopted computers early and now regard them as indispensable tools. Computerization elsewhere in the university has proceeded more slowly, but is now almost universal. Few faculty members pass up the opportunity to acquire a desktop computer with which to make use of information sources offered by the campus information network. Many routine jobs, such as maintenance of class lists, marks and assignment-grading, are done on the computer. Most scholars now produce their manuscripts on a machine, because of the relative ease of creating successive drafts. One constituency that remains largely uninvolved in information technology consists of students. For the most part, they still pursue their research assignments in time-honored ways: penned notes shuffled into a written draft which is then laboriously typed and, finally, proofread (one hopes) and corrected by hand.

There are several reasons why students are being left out of the process of change. One is the price of the hardware and software. With basic tuition on the rise, is it realistic to expect students to bear the cost of equipping themselves with computers? Another problem is the lack of opportunity to learn how the technology works, whether the question involves a word processor or finding one's way around a complicated information base. Instruction usually is offered informally and haphazardly, if at all. The assumption in most cases is that, if students want to use technology, they will solve its puzzles themselves. This is the equivalent of expecting them to acquire a command of grammar and rhetoric by osmosis.

A laissez-faire attitude on the university's part is unacceptable in the modern world. As faculty become more adept in using technology, they must find ways of passing their knowledge on to their students. There will be several positive results: the quality of written assignments may well improve, the insights produced by research may be more profound because creativity has replaced drudgery, and students gain practical skills while completing their course work. On balance, the arguments in favor of teaching the operation of

information technology outweigh the objections. There are, however, a few substantial hurdles to be overcome.

Teaching computerized research and writing skills poses a dilemma that is analogous to the running battle over who ought to teach grammar to students. About a generation ago, English departments abandoned their traditional role and left grammar to the historians, philosophers and others who wished to make it an issue when marking student work. Today, if anecdotal evidence is reliable, no one keeps a systematic watch on the language. In the name of creative expression, almost anything goes. Who, then, would accept an obligation to teach computer literacy to the student body at large? Surely not the English department, or, for that matter, any other department in the university. The answer therefore appears to be that responsibility should be dispersed among all the departments, with each contributing its particular insight.

Another obstacle to the ready acceptance of information technology is the argument that universities educate minds rather than train job-seekers. Machine-related skills, many faculty believe, ought to be acquired outside the university classroom. Those students who make use of information technology may well be rewarded with higher marks; those who do not will not be penalized on that account. For the most part, faculty take an instrumental view of technology: it may assist, but does not fundamentally alter the university's traditional mission. Ever since the middle ages, that role has been to create knowledge, to develop critical intelligence among students and to encourage scholarship. There is no conflict between these goals and the adoption of technological means of realizing them.

Research, after all, is the basis of scholarship in all disciplines. Outside the natural sciences, research is conducted primarily in libraries, where knowledge is stored mainly on paper and where the appropriate finding aids have existed for centuries. Indexes, abstracts and catalogs enable researchers to use the library's resources efficiently. In recent years computer technology has been applied with notable success to the creation of electronic tools capable of

providing comprehensive access to the literature of all disciplines. It is in the library that scholarship and information technology first converged. Librarians nevertheless ought not to forget, as a British scholar pointed out, that "an information service that focuses on technological matters must be constituted on the premise that it is aimed at an audience of scholars, not of technologists.... [T]echnology is a means to scholarship, and not an end in itself."[13]

Libraries have been on the cutting edge of information technology since the 1960s. Library catalogs became candidates for automation thirty years ago and today only the smallest libraries still maintain a card catalog. The best automated systems, of which BuCAT is one, offer author, title, subject and open keyword searching, thus allowing the maximum number of citations to be located. An innovative aspect of BuCAT is its ability to index a variety of material, including journal articles and government publications, and to include abstracts with many citations. Comprehensive access to all of the library's collections therefore is possible.

Electronic browsing is the next logical step for automated library catalogs to take. A joint research project between Cornell University and Xerox Corporation aims to create "links between a library catalog and the material itself," using digital technology.[14] Bibliographic data will be supplemented by access to information about a book's contents. Portions of the work, or the whole thing, then may be downloaded or printed. Xerox Corporation is developing the digital image technology that allows brittle or deteriorated books to be scanned and their contents converted into an electronic format. This technology ultimately may be used to create a fully electronic library. Such

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[13]May Katzen, "A national information network," *Scholarly Publishing* (July, 1988): 211.

[14]Lynne Personius and Anne Kenney, "The CLASS Project: preservation of and access to Cornell Library materials," *CIT News*, (Summer, 1992): 10.

developments are little known outside of the library world, where interest in technological innovation runs high.

Familiarity with the automated library catalog normally constitutes a student's sole acquaintance with information technology. Faculty may use online literature searches in the course of their research, but the cost is beyond the means of many students. Their exposure to online databases consequently is limited. Many libraries offer a range of CD-ROM products, each requiring its own host PC and laser-disk reader. Others network CD-ROMs so that more than one user can be accommodated at a time. Brandon University Library currently confines its use of CD-ROM to *Books in Print Plus* and *Bibliodisc*, because our aim is to avoid forcing library users to learn many search protocols. We prefer, instead, to mount commercial databases on the VAX mini-computer and to make them available over the campus information network (MONET) where they would be searchable using BuCAT commands. Some technical work remains to be done before this goal is reached, but success is not far off.

Local-Area-Network (LAN) technology now is capable of providing access to multiple CD-ROM information bases, and of accommodating more than one user at a time. Only financial constraints prevent the library from offering several of the most popular CD-ROM products such as *Silverplatter* and *Information Access*. To deprive students and faculty of these resources is false economy in the long run, because research is the essence of scholarly work in any university. When opportunities are restricted, the quality of education suffers.

Despite tight finances, Brandon University, in some respects, is well positioned to move beyond current applications of information technology and to make innovative use of computers in the teaching process. For one thing this campus is almost completely wired for computer communication. The new library building has an extensive electric power and communication grid, which means that each work and study space may be connected to the campus information network. Our plan is not to provide a desktop PC for each study

space, but rather is to make it possible for users to operate their own machines at any study space. Portable computers are now so small and light--if not inexpensive--that they may be carried about with ease. If loaded with familiar software, they are capable of becoming a student's constant companion throughout his/her academic career. Library design, from this point on, has to take account of the educational implications of portable computing power.

## Notebook Computers and Library Design

A short time ago, two experts on library design predicted that "over the next decade, the computer will not be an instrument that is carried around more than was the portable typewriter in the 1950s."[15] Written just before notebook computers arrived on the scene, this prognostication missed the mark. The analogy between notebook-sized computers and portable typewriters breaks down mainly because the notebook is a far more functional machine. It operates quietly enough to be used in a library setting without disturbing those seated nearby. But the computer's real superiority rests on its ability to put the user in touch with his/her sources through a series of steps that become familiar through repetition. The results of a literature search may be saved on disk, edited and printed--all without leaving a library study space. According to one recent prediction:

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[15]Philip D. Leighton and David C. Weber, "The influence of computer technology on academic library buildings: a slice of recent history," in: John Richardson, Jr. and Jinnie Y. Davis, eds., *Academic Librarianship Past, Present, and Future: A Festschrift in Honor of David Kaser* (Englewood, CO, 1989), p. 25.

> Stationary PCs will still be used in the year 2000 for technical work, but most people are likely to use small, portable computers like the "laptops" and "palmtops" now being developed. These should be user-friendly consumer electronic devices, almost like a smart TV remote control, connected to information networks through the same technology now used in cellular phones....[16]

The author of this scenario believes that "computers will be ubiquitous" ten years from now. Developers of the "electronic campus" at Northwest Missouri State University, point out that

> the microcomputer is an interim technology which is even now being merged into the notebook computer.... Within the decade the predominant mode of computing on campus will be notebook computers which can easily be connected through ubiquitous outlets to large powerful networks of computers permitting the sharing of nearly any imaginable digitized resource.[17]

From the standpoint of building design, the assumption that library users will shortly be equipping themselves with notebooks has certain implications. For one thing, there is no need to plan for separate computer rooms or to devote space to banks of PCs for public use. From the library's perspective, the investment in computerization is less, because it is unnecessary to build the extra space or to assume responsibility for maintaining an array of microcomputers. All that is needed to provide public access to the online catalog is a number of

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[16]William E. Halal, "The information technology revolution," *The Futurist*, 26 (July-August, 1992): 11.

[17]Jon T. Rickman and Dean L. Hubbard, *The Electronic Campus* (Maryville, MO, 1992), p. 91. This short book is "a case history of the first comprehensive high-access computing network at a public university."

OPAC terminals situated close to point-of-use in the library's collections. These "dedicated" terminals serve only as a means of consulting the catalog.[18]

There is no reason why a few desktop PCs cannot be supplied for public use; but their numbers should be small. It may be that a few workstations will have to be devoted to CD-ROM systems, at least in the short term. CD-ROM offers fast and--from the user's point of view--free access to large citation or full-text databases. These systems, as previously noted, may be networked so that more than one person can use them; and access to a CD-ROM local-area-network can be provided from each study space. But there is a good reason not to proliferate such systems: each one has its own search protocol, which users have to learn. Now it may come to pass, over the next few years, that a standard computer interface will emerge (e.g. SR or Z39.50) that will permit a familiar protocol to be translated automatically for a foreign system. Until that happens, however, our preference is to mount commercial CD-ROM databases on the VAX and make them available over MONET.

Network access from any study space in the library is the key to using notebook computers effectively. Carrels and tables have built-in wire management systems that include a four-plex plug and an Ethernet connection that enable users simply to plug in their own machines and to go to work. After logging onto the network, library users may select the databases, online utilities or functions of their choice. The machine itself and its operation are already familiar.

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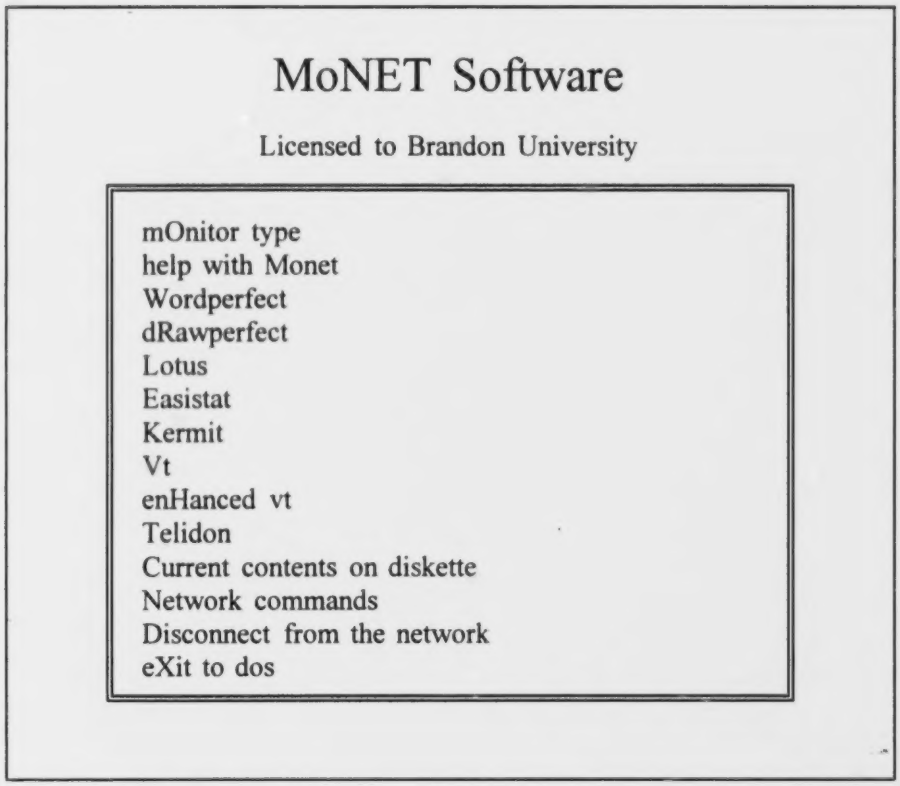
[18]Richard J. Bazillion, "Personal computing and academic library design in the 1990s," *Computers in Libraries*, 12 (March, 1992): 10-12.




Two large questions loom over this conception of library design and service to users:

---How can notebook computers be placed in the hands of students at an affordable price?

---How can information technology best be integrated into the curriculum, so that students quickly become adept at using it?

Ideas and suggestions on both of these issues are emerging, but no satisfactory answers have yet emerged. There are a few models available in the United States, of which the professional literature so far has taken inadequate notice. If Brandon University decides to follow a similar course, it will be helping to blaze a new trail. We do have the great advantage of a new building that is sufficiently flexible in design and electronic infrastructure to enable us to apply

information technology in a variety of ways. The directions we follow depend on the usual combination of financial realities and willingness to innovate.

Current prices of notebook computers are too high to encourage widespread student use. The university might agree to a hefty subsidy, or perhaps negotiate an agreement with a computer manufacturer that would see a substantial price reduction in return for access to a captive university market. Another approach followed by some universities in the United States is to amortize the purchase price over the four years required to obtain a degree. This option lightens the financial burden for students, but commits the institution to a large capital investment in an inventory of machines. Before embarking on such a course, policy decisions respecting computer use in the classroom would be needed. Alternatively, private industry might be interested in making equipment available, if it can be shown that graduates will be taught to use information technology during their university careers. In other words, industry eventually would realize a practical return on its investment. The next step would be to conclude a service agreement with a local firm, so that repairs or upgrades could be made quickly.

Once the logistical issue is settled, the whole conception stands or falls on the willingness of faculty to bring information technology into the classroom. There have to be obvious practical advantages, if faculty are going to be asked to restructure their courses in order to accommodate technology. Whether or not the capability exists, new directions require careful preparation and justification of their presumed benefits. In the case of Brandon University, the new library is equipped to be an "educational instrument" by virtue of its built-in electronic network. How, then, can that potential be used to further teaching in the university?

Two obvious applications of information technology are to distance education courses and to the library support offered to such courses. BuCAT already is accessible from a number of off-campus sites and easily can be made available via modem wherever telephone service is provided. An explanation of

the library's involvement in distance education has been published elsewhere.[19] The present discussion focuses on aspects of information technology that may be applied equally well to on- or off-campus teaching.

## Information Technology and the University

Between five and ten years ago, as noted above, "computer literacy" meant the teaching of programming languages such as BASIC, Pascal and C. The emphasis today is not exclusively, or even in large part, on computer programming. No one needs to know how a computer receives its instructions in order to make it work. Rapid evolution in the quality and range of programs has focused attention on the application of software to intellectual problems that involve the acquisition and analysis of data. Information technology can be used in the process of research without an expert knowledge of data-handling techniques. "Computer literacy," as far as most people now are concerned, means the ability to consult information systems such as citation databases and to operate several relevant software packages. The question is how best to incorporate this definition into the curriculum.

Some disciplines are more advanced than others in their adoption of information technology. Business and nursing are two examples of fields in which computers have been used for some time to analyze large bodies of data

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[19]Richard J. Bazillion and Connie Braun, "Technology and library users: automation and outreach: library services to off-campus students," *Journal of Distance Education*, 7 (Fall, 1992): 67-75.

in order to make administrative decisions.[20] Business schools are using large-scale computer simulations to create "real-world" problems for students to solve.[21] As professional schools demand higher levels of computer literacy in their students, undergraduate teaching should reflect the changing times. A similar message is coming from the marketplace, in which information technology is achieving a general acceptance.

Those who teach in the liberal-arts disciplines may resent technology's recent upsurge, because the machines threaten to invade a traditional refuge of the humanities. Contemplation may appear to be an activity that is valued less than the rapid distillation of "insights" from masses of raw data processed by a computer. The very term "information society" implies a historical epoch in which data flows too quickly for human minds to synthesize new knowledge from the deluge of "information" generated within society. Computers contribute to this flood by facilitating global communication networks over which anyone with something to say may address everyone else on the system. Junk faxes, junk e-mail and junk computer conferences are the dark side of a technology which, notwithstanding its faults, has the potential to advance human understanding. "Computers give you information," said an American university president some years ago. "The liberal arts give you knowledge."[22] How do we get the two of them together?

There is plenty of room for experimentation and innovation, because "few academic programs use PC tools to teach the conceptual, information management, analytic and decision-making skills that ultimately must be used

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[20]John Eisner and Thomas Carter, "University faculty teaching activities in an electronic curriculum," *Educational Technology*, 29 (April, 1989): 17.

[21]Richard M. Cyert, "The impact of microcomputers on education," *Perspectives in Computing*, 6 (Fall, 1986): 6.

[22]Leland Miles, "Liberal arts in an age of technology," *American Education*, 20 (June, 1984): 4.

in most organizations."[23] Yet faculty in the liberal arts have no trouble discovering potential applications for the technology. A professor at Brown University, who teaches journalistic writing, comments: "Most of what we're doing involves rhetoric emphasis, moving things around, handling material, rearranging your examples; and it seems to me that the computer will be particularly useful for that purpose." A colleague at Brown who teaches music finds that the computer "could take so much of the drudgery" out of copying scores.[24] These observations are typical of opinions expressed by faculty who either have used computers in classroom settings or who easily perceive advantages in so doing.[25] (The literature does, however, contain contrary examples of which faculty should be aware.[26])

In the mid-1980s the so-called "Star Wars universities" (M.I.T., Brown and Carnegie-Mellon) invested some $200,000,000 in total in scholars' workstations and campus information network infrastructure. Their aim was to place a computer in the hands of all faculty and students, and to create a comprehensive network of informational databases and online utilities. Seven years later Brandon University is at the very point that these larger and far wealthier institutions hoped to reach not so long ago. We have established a campus information network and an online library catalog with a much smaller

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[23]Peter W. Stonebraker and Ray W. Coye, "Teaching with personal computers," *College Teaching*, 36 (Spring, 1988): 69.

[24]"'Star Wars' Universities": 14.

[25]Cynthia L. Selfe and Billie J. Wahlstrom, "Computers and writing: casting a broader net with theory and research," *Computers and the Humanities*, 22 (1988): 57-66.

[26]Jeannette Harris, "Student writers and word processing: a preliminary evaluation," *College Composition and Communication*, 36 (October, 1985): 323-330. James V. Catano, "Computer-based writing: navigating the fluid text," *College Composition and Communication*, 36 (October, 1985): 309-316.

investment, and are now in a position to move to the next level of attainment: the full integration of computerization into the curriculum.

In order to reach this goal, certain steps have to be followed:

---each course to contain a research component consisting of a review of the information sources belonging to the particular field

---course assignments to include a research project in which students may demonstrate a knowledge of information sources, analytical ability and skill in writing a research paper

---instructors to require the use of a computer in the conduct of bibliographical research and the production of course assignments

---students to use online utilities such as the campus e-mail system (to exchange information with the instructor), the automated library catalog, relevant informational databases and commercial citation services (e.g. DIALOG, PsychLit, ChemAbs)

---arrangements to be made to help students acquire skill in computer-research techniques, data analysis and word processing early in their academic careers; coordination between teaching faculty and the library is the key to success

---students enrolled in university courses via distance education require full access to online services offered by the university and made available over the Datapac network, e.g. BuCAT, e-mail

Instructors presumably would organize their courses in such a way as to incorporate these elements. As students and faculty become more comfortable with the idea of a computerized learning environment, information technology

may be applied more creatively. Technology's natural course of evolution will provide an expanding array of opportunities as time passes.

As other universities have discovered, information technology is easy to discuss in the abstract but difficult to apply to the practical activity of teaching. Drexel University, for example, invested $2.8 million (from the Pew Memorial Trust) in 1983, just to involve faculty in the process of change.[27] The intervening decade has seen vast changes in the technology, which have made it more accessible to users. A massive financial commitment to faculty preparation is unnecessary in 1993, because the machines and their software are, at the same time, more powerful and more comprehensible. Ten years down the road, it undoubtedly will be easier to see how computerization can assist the teaching function.

Another advantage we now have is a campus network environment that allows application software to be centrally distributed to PCs anywhere on the system. The result is "transparent cooperative processing between the workstation and centralized computing facilities," including software and print distribution.[28] All such LANs accomplish the following tasks:

---prevention of unauthorized copying of software resident on the central computer

---limitation of the number of simultaneous users consistent with the software's licence (e.g. only four users may access *Current Contents* at one time)

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[27]*Preparing the Faculty. Faculty Development for the Microcomputing Program*, (Philadelphia: Drexel University, Microcomputing Program, 1984), ERIC, ED 250968.

[28]Antony S. Halaris and Lynda W. Sloan, "An implementation strategy for cooperative computing and campus connectivity," in: *Information Technology: Making it All Fit. Track VI: Outstanding Applications* (Proceedings of the CAUSE National Conference, 1989), ERIC, ED 305031, p. 26.

---restriction of software use to the particular LAN environment specified in site licences

Within these regulations, software and database access may be distributed to any PC on the system, whether the machine is a faculty member's office desktop or a student's notebook temporarily connected to the LAN from a study space in the library.

Faculty who wish to add a research-skills component to a course, as the first step toward more intensive computer use, will require access to the campus information network (MONET) from their classrooms. MONET may be thought of as the local branch of an international system of electronic highways that links the campus with the rest of the world via the Internet. All Internet services, ranging from electronic journals to the online catalogs of universities worldwide, are accessible to any MONET password holder. The cost is manageable because of hefty government subsidies to facilitate the Internet, and students should be aware of this important electronic utility.[29]

For purposes of in-class demonstration, a low-heat overhead projector and data-display pad are required equipment. Any portable computer with an RGB or RS-232 port can be connected to the display pad and to MONET. Incoming data is then projected on a screen for all to see. Online searching, software instruction and document critiques are but three functions that instructors may perform online in front of a class. Literature searches, in BuCAT or another system, are an invaluable demonstration of the importance of bibliographical research.

Faculty have no time to spare for the teaching of computer basics, such as the operation of DOS. There is a program, called "Seminar-on-a-Disk for PC

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[29]The history and development of the Internet is discussed in Lynch and Preston, "Internet access to information resources."

and DOS Fundamentals," that has proven to be effective.[30] Similar tutorial programs are available for "dBASE IV," "Lotus 1-2-3," and "WordPerfect." Licensing and financial arrangements are possible that allow this software to be sold in a campus bookstore at nominal cost to students.

Depending on the discipline, there is a growing body of course-specific software from which to choose.[31] Many of these programs are linked to large information bases stored on CD-ROM, e.g. the *Oxford English Dictionary*, *Granger's World of Poetry*, and several projects aimed at preserving classical literature on disk.[32] Libraries usually mount CD-ROM on independent PCs that can be used by only one person at a time. CD-ROM drives, however, can be networked, either in a LAN or on MONET. The approach on this campus is to transfer the data to the VAX and to search it using a familiar protocol such as BuCAT's. Either way, the information is accessible to any PC connected to MONET.

LAN access is important not only in facilitating research, but also in the teaching of specific subjects. Writing is a good example. One scholar describes how network teaching occurs:

> Students who write on a network can participate in collaborative environments not duplicable in any other way, and the network can provide students with resources that would not otherwise be available. With a network, students sitting at different machines

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[30]Sold by InfoSource, Inc., Orlando, Florida, and used successfully in the College of Engineering, Virginia Polytechnic and State University. See *Chronicle of Higher Education*, November 25, 1992: A14.

[31]Advice on the application of computers to archaeology, biblical and classical studies, literary text analysis and philosophy may be found in: Helen R. Tibbo, "Information systems for the humanities," *Annual Review of Information Science and Technology*, 26 (1991), pp. 305-318.

[32]For a description of the third example, see Linda W. Helgerson, "CD-ROM and scholarly research in the humanities," *Computers and the Humanities*, 22 (1988): 111-116.

> can share an electronic workspace, conduct a discussion in writing, compose or revise one text collaboratively and simultaneously. By combining collaborative writing strategies with computer-based writing techniques, teachers have the opportunity to link two powerful currents in writing instruction.[33]

Instructors nevertheless should bear in mind "that students often feel uncertain, uncomfortable, and even frustrated at the outset of a computerized composition course."[34] Another point is that the computer screen and the printed page have their own distinct "grammars," which means that people write in quite different ways on a computer and on paper.[35] The word processor's unique contribution is to make "revision a central part of the writing process," and thus to stimulate creativity.[36] Gradual introduction of the technology helps to reduce resistance to it and, moreover, keeps the subject of writing at the forefront. Once the technology becomes familiar, learning to write well follows more easily than in pre-computer times. The intellectual process involved here is qualitatively different from that associated with earlier typewriting technology. There is a more dynamic editorial process at work, along with potentially greater

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[33]Michael Spitzer, "Local and global networking: implications for the future," in: Deborah H. Holdstein and Cynthia L. Selfe (eds.), *Computers and Writing: Theory, Research, Practice* (New York, 1990), pp. 59-60.

[34]John S. Dinan, Rebecca Gagnon and Jennifer Taylor, "Integrating computers into the writing classroom: some guidelines," *Computers and Composition* 3 (March, 1986): 34.

[35]Cynthia L. Selfe, "Redefining literacy: the multilayered grammars of computers," in: Gail E. Hawisher and Cynthia L. Selfe (eds.), *Critical Perspectives in Computers and Composition Instruction* (New York, 1989), pp. 3-15.

[36]Michael G. Wessells, *Computer, Self, and Society* (Englewood Cliffs, 1990), p. 235.

interaction between student and instructor. This strategy, moreover, is capable of breaching disciplinary barriers.

Information technology, by its very nature, is interdisciplinary and this quality is capable of inspiring new courses that combine two or more fields. San Francisco State University, for example, offers courses such as the following:

---"Cosmologies and World Views" (English, physics/astronomy)

---"Time in Human Consciousness" (philosophy, biology)

---"The Copernican Revolution" (physics/astronomy, humanities)

---"Split Brain/Split Culture" (philosophy, biology)[37]

The keyword-searching capability of advanced online catalogs (such as BuCAT) and commercial information bases enables students to discover interdisciplinary connections in the course of their research and to locate material in which the linkages are discussed. Instructors in fields such as sociology and religion, which routinely cross disciplinary lines, therefore may expect their students to be able to cite literature that exemplifies cross-disciplinary research. Since the computer is itself a cultural artifact, its social and intellectual ramifications may be explored in a variety of courses offered under the auspices of assorted disciplines, e.g. history, philosophy, mathematics.

Another example of the computer's interdisciplinary nature is the widespread applicability of spreadsheet programs such as *Lotus 1-2-3*, which "automatically [change] all related numbers on a matrix of rows and columns when one number is changed."[38] Data need not be numerical, but may also be textual or presented as formulae. This feature allows spreadsheets to be used as modelling and simulating devices in such fields as economics, business,

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[37]Ruth Schwartz, "Computers and the arts," *College Teaching*, 34 (Winter, 1986): 13.

[38]Barry Heerman, *Teaching and Learning with Computers: A Guide for College Faculty and Administrators* (San Francisco, 1988), p. 87; Richard E. Towey, "Computer applications: economics instruction with Lotus 1-2-3," *Economic Inquiry* 27 (April, 1989): 363-366.

psychology and physics.[39] The ease with which spreadsheet programs manipulate variables can be deceiving, and students still need to know what is going on behind the scenes. Data analysis by machine is not to be construed as a substitute for thought.

Some proponents of the liberal arts believe that computers in fact have revolutionized the relationship among music, art and rhetoric. "When the arts are digitized, as they now have all been," writes Richard A. Lanham, "they become radically interchangeable."[40] A painting may be translated into music, by using a program designed for that purpose. Works created digitally (such as this paper) are never finished and absolute, but alterable by creator and audience alike. The ability to move around among the arts, irrespective of individual talent in one or all of them, has implications for teaching and learning. Going far beyond the technology of information retrieval, it is theoretically possible to make the arts accessible to students who have no special affinity for them. Computerization seems to have created, in Lanham's words, "a neural mix [that] seems almost totally new."[41]

As a research tool, a writing instrument and a subject of study in its own right, the computer is capable of being an integral part of the university's teaching activity. "Evidence suggests," writes one professor of English, "that the computer will have a lasting and deep effect on the instructional context."[42] Instructional software, electronic indexes and abstracts, computational programs

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[39]Charles E. Fisher, "On the design and use of forecasting experiments in teaching macroeconomics," *Simulation & Gaming* 22 (March, 1991): 75-82.

[40]Richard A. Lanham, "The extraordinary convergence: democracy, technology, theory and the university curriculum," *South Atlantic Quarterly* 89 (Winter, 1990): 35.

[41]Lanham, "Extraordinary convergence" 35.

[42]Thomas T. Barker, "Computers and the instructional context," in: Deborah H. Holdstein and Cynthia L. Selfe (eds.), *Computers and Writing: Theory, Research, Practice* (New York, 1990), p. 8.

and text editors either may reside on a portable computer's hard disk or be made accessible over the campus information network. If students own their machines, they can tackle course assignments from a library study space or a residence room. Work-in-progress--drafts of papers, bibliographies, notes, electronic texts and so on--are instantly available. There is much to be said, moreover, for possessing a computer that, with constant use, becomes a familiar object. In the process of applying information technology to their studies, students acquire research and writing skills that will serve them well in the contemporary job market. Those who are pursuing degrees in the liberal arts will profit as much in this regard as students in more vocational programs. A tangible benefit of adopting information technology is the very practical one of being able to use a machine that is indeed ubiquitous in modern society.

## Is a Revolution in Progress?

Signs abound that the social utility of universities is being challenged. Several provinces have unleashed commissions of inquiry, whose mission is to find ways of holding universities accountable for their expenditure of public funds.[43] Higher education faces a situation reminiscent of Hermann Hesse's *Glass Bead Game*, in which Magister Ludi addresses his Board of Educators thus:

> "... we Castalians [read: "academics"]... depend vitally on the condition of the country and the will of the people. We eat our bread, use our libraries, expand our schools and archives--but if the nation no longer wants to authorize this, or if it should be struck by impoverishment, war, and so on, then our life of studying would be over in a minute. Some

[43] *Globe & Mail*, 04 March 1993.

> day our country might decide that its Castalia and our culture are a luxury it can no longer afford.[44]

Quite possibly our own moment of truth has come, now that the university as a social institution finds itself under public scrutiny and soon, perhaps, under siege. How should we respond?

Higher education's crisis coincides with a period of revolutionary change in human communications and in society's means of handling information. Herein lies our opportunity. If it is true that, "increasingly, the dominant capital expense will be for information, either in skill of workers or the data necessary for industry to conduct its business,"[45] then universities have a chance to make significant gains. Our role is to educate those who will live and work in the information society. Skill in the use of information technology, along with an understanding of its implications, is ours to impart--but only if we can make a collective decision to take action. The important thing is to ensure that education and information technology evolve together, not in isolation. Electronic communications are reaching a point at which it is "theoretically possible to contemplate a world in which every person on the planet is both a broadcaster and a recipient of information."[46] Hierarchical institutions of all sorts, including universities, may simply be bypassed and excluded from what might be called the "global innovation network." Should this happen, universities would lose their civilizing and acculturating role, to the ultimate detriment of cultural life as a whole. No matter how pervasive technology becomes, there must still be a place for the liberal arts and sciences. That is our imperative, however, not

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[44]Hermann Hesse, *Magister Ludi (The Glass Bead Game)* (New York, 1970), p. 323.

[45]Steve Bankes and Carl Builder, "Seizing the moment: harnessing the information technologies," *The Information Society* 8 (1992): 12.

[46]Bankes and Builder, "Seizing the moment": 15.

necessarily that of the society that, for the moment at least, supports us "Castalians."

In order for us to achieve some degree of permanence in the modern age for an essentially medieval institution, we have to study the information society and not merely adopt its technological instruments. There is a research agenda, developed by scholars at the RAND Corporation, that focuses attention on various aspects of the "Information Revolution": political systems, conflict resolution, economic disparity, legal implications and social consequences.[47] One might add the historical development of an information society, taking into account the various changes in social, political and economic organization that may be attributed to the Information Revolution. There is room, in other words, to teach both substance and technique as society struggles to assimilate the ramifications of electronic technology. Theory and practice belong together, because there is an obligation both to understand what is happening while, at the same time, finding new ways to apply the knowledge gained.

In the interest of securing our own institutional future, we have to do several things simultaneously. The first is to begin developing courses that apply information technology to the specific research assignments required of students. A second, longer-range task is to create new courses in the history, sociology, psychology, etc. of the information society, so that students gain an intellectual context into which to place contemporary events. A third concern is to make sure that our own campus's technological infrastructure does not become progressively obsolete due to misplaced fiscal priorities. The new library will be on the cutting edge only for a short time; but while it occupies that position, it can provide an impetus to further progress as technology evolves.

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[47]Bankes and Builder, "Seizing the moment": 20ff. Appendix B to this article discusses potential information linkages among Canada, the United States and Mexico in the context of NAFTA, and is particularly suggestive of research possibilities.

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## APPENDIX

### A Preliminary Bibliography of Course Software

Connie Braun
Head, Information Services

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Computational methods can now make detailed and accurate predictions of the structures of inorganic materials. Electronic-structure calculations are being performed for increasingly large systems, and simulation methods based on 'effective potentials' may now be used to model complex materials. One of the most exciting fields of application is mineralogy, which poses a major challenge to the predictive capacity of contemporary computational techniques.

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A new undergraduate program that stresses interdisciplinary connectedness, formal reasoning, intercultural understanding, and speaking and writing skills implemented at Hamline University is described. The Hamline Plan provides skills that students demand: computer literacy and real-life work experience.

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A survey of 173 Canadian modern language departments concerning the extent of computer use for teaching, the kinds of hardware and software used, and instructor and student satisfaction with computer-assisted language instruction is reported. Canadian-developed authoring systems are also discussed. A table of CALL courseware and the questionnaire are appended.

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With appropriate software, university networks of personal workstations will facilitate remedial learning, enhance comprehension and problem-solving abilities, improve the student's motivation to learn, and stimulate learning outside the classroom.

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Fitzpatrick, Charlie. "Computers in geography instruction," *Journal of Geography* 89 (July/August 1990): 148-149.

Examines how geography is particularly well suited to classroom uses of computers. Discusses available geography software in three categories: database, exploratory, and simulation, linking programs to the skills they develop. Provides a list of catalogs and geographic computer programs that teachers may find helpful.

Freeman, Ardis. "Instructional software features which aid the anxious student," *Performance and Instruction* 24 (July/August, 1985): 12, 15.

Briefly discusses current views of the way anxiety decreases students' learning from instructional software and describes ways software designers might compensate for the learning problems of anxious students.

Grable-Wallace, Lisa. "Suggested courseware for the non-calculus physics student: fluid dynamics, kinetic theory, and thermal properties, *Physics Teacher* 27 (January, 1989): 35-37.

Evaluates seven courseware packages covering the topics of fluid dynamics, kinetic theory, and thermal properties. Discusses the price range, sub-topics, program type, interaction, time, calculus required, graphics, and comments of each courseware. Selects some packages based on the criteria.

Gray, Robert. "Computer programs and mathematical proofs," *The Mathematical Intelligencer* 13 (1991): 45-48.

An article which portrays the interconnection between computer science and mathematics.

Hargrove, Eugene C. "Moria: a computer simulation for introductory philosophy," *Teaching Philosophy* 9 (September, 1986): 219-236.

Harris, Jeanette. "Student writers and word processing: a preliminary evaluation," *College Composition and Communication* 36 (October, 1985): 323-330.

Hodges, D. et al. "Microcomputers in university instrumental music education courses. *Dialogue in Instrumental Music Education* 7 (1983): 4-7.

Karplus, Martin and Petsko, Gregory A. "Molecular dynamics simulations in biology," *Nature* 347 (October 18, 1990): 631-639.

Katzen, May. "The application of computers in the humanities: a view from Britain," *Information Processing and Management* 22 (1986): 259-267.
Discusses the recent increase in the use of computers in the humanities disciplines.

Kennedy, Mary Lynch. "The composing process of college students writing from sources," *Written Communication* 2 (October, 1985): 434-456.

Kowalski, Rosemary. "Computer CONFERencing in the English composition classroom," *Educational Technology* 29 (April, 1989): 29-32.
Describes the use of a computer conferencing program, Confer II, in freshman college composition classes. Benefits discussed include the opportunity to expand classroom discussions; promotion of interactions between students, both class-related and purely social; and exploration of the link between conversation and expressive writing.

Kozma, Robert B. "The technological revolution comes to the classroom," *Change* (January/February, 1991): 10-23.
Understanding the impact of computers in higher education means understanding the complex net of reciprocal relationships between people and situations; it means examining the use and impact of technology in context.

Kramer, David W. "Interactive biology with Videodisc," *American Biology Teacher* 53 (March, 1991): 185-188.

Lam, Anton S.Y. and Chang, C.S. "Prototype of a courseware production and presentation system," *Educational Technology* 32 (April, 1992): 20-27.
Describes the design of a prototype of a computerized courseware production and presentation system that provides a user-friendly environment for the creation, maintenance, and presentation of courseware. Object-oriented material is discussed, types of

operations that may act on the objects are explained, and interaction techniques are described.

Loughridge, Brendan. "Information technology, the humanities and the library," *Journal of Information Science* 15 (1989): 277-286.

Mahoney, Joyce. "Suggested courseware for the non-calculus physics student: measurement, vectors, and one-dimensional motion," *Physics Teacher* 26 (October, 1988): 437-439.

Evaluates 16 commercially available courseware packages covering topics for introductory physics. Discusses the price, sub-topics, program type, interaction, time, calculus required, graphics, and comments of each program. Recommends two packages in measurement and vectors, and one-dimensional motion respectively.

O'Haver, T.C. "Applications of computers and computer software in teaching analytical chemistry," *Analytical Chemistry* 63 (May 1, 1991): 521-534.

Olson, Donald W. and Doescher, Russell L. "Astronomical computing: rainbow simulator," *Sky & Telescope* 81 (February, 1991): 199-201.

Permaloff, Anne and Grafton, Carl. "Using the microcomputer in the classroom: initial consideration," *PS: Political Science & Politics* 24 (December, 1991): 689-694.

Describes how the personal computer or microcomputer may be used as a pedagogical tool in the classroom.

Perone, M. "Computer-based methodology laboratories. 1. An undergraduate course in experimental psychology," *Behavior Research Methods and Instrumentation* 23 (May 1991): 121-126.

Selfe, Cynthia L. and Wahlstrom, Billie J. "Computers and writing: casting a broader net with theory and research," *Computers and the Humanities* 22 (1988): 57-66.

This papers suggests for areas of exploration regarding computers in the English classroom: (1) computers and teaching writing, (2) computers and language theory, (3) computers and learning from the past, (4) computer research in other fields.

Sigismondi, Linda A. "Integrating basic computer skills into science classes: analysis of ecological data," *American Biological Teacher* 52 (May, 1990): 297-301.

"Software," *Journal of Chemical Education* 66 (May 1989): 405.

"Spreadsheets in Physical Chemistry" contains reviewed and classroom tested Lotus 1-2-3 and SuperCalc IV templates and handouts designed for use in physical chemistry courses. The 21 templates keyed to Atkins' physical chemistry textbook, the 7 numerical methods templates, and the 10 simulation templates are discussed.

Tanner, John J. "A computer-based approach to teaching quantum dynamics," *Journal of Chemical Education* 67 (November, 1990): 917-921.

"Teaching a course in computer-assisted statistical analysis," *Teaching of Psychology* 12 (December 1985): 225-226.

Described and evaluated is a course structured around SPSS (the Statistical Packages for Social Sciences) that helps psychology students review what they have learned in an introductory statistics course and apply these quantitative skills to other courses. Student evaluation showed that course objectives were met.

"Teaching the use of computers: a case study," *Teaching of Psychology* 12 (October, 1985): 171-172.

Described is a college course on the use of computers in psychology that included an introduction to computers, computing, word processing, data analysis, data acquisition, artificial intelligence, computer assisted instruction, simulation, and modelling. Students conducted independent research projects using the computer.

Towey, Richard E. "Computer applications: Economics instruction with Lotus 1-2-3," *Economic Inquiry* 27 (April, 1989): 363-366.

Troost, Dirk; Blackburn, David; Robinson, Ian; and Callison, Richard. "A PC-based textbook for the marine sciences," *Impact of Science on Society* 164: 339-351.

Ulett, Kathleen C. "Computer connection: the 21st century music series" *American Music Teacher* 41 (April, 1992): 22-23.

Kathleen C. Ulett reviews The 21st Century Music Series, a software program from Electronic Courseware Systems Inc. designed to teach students to read music through a programmed sequence using a keyboard.